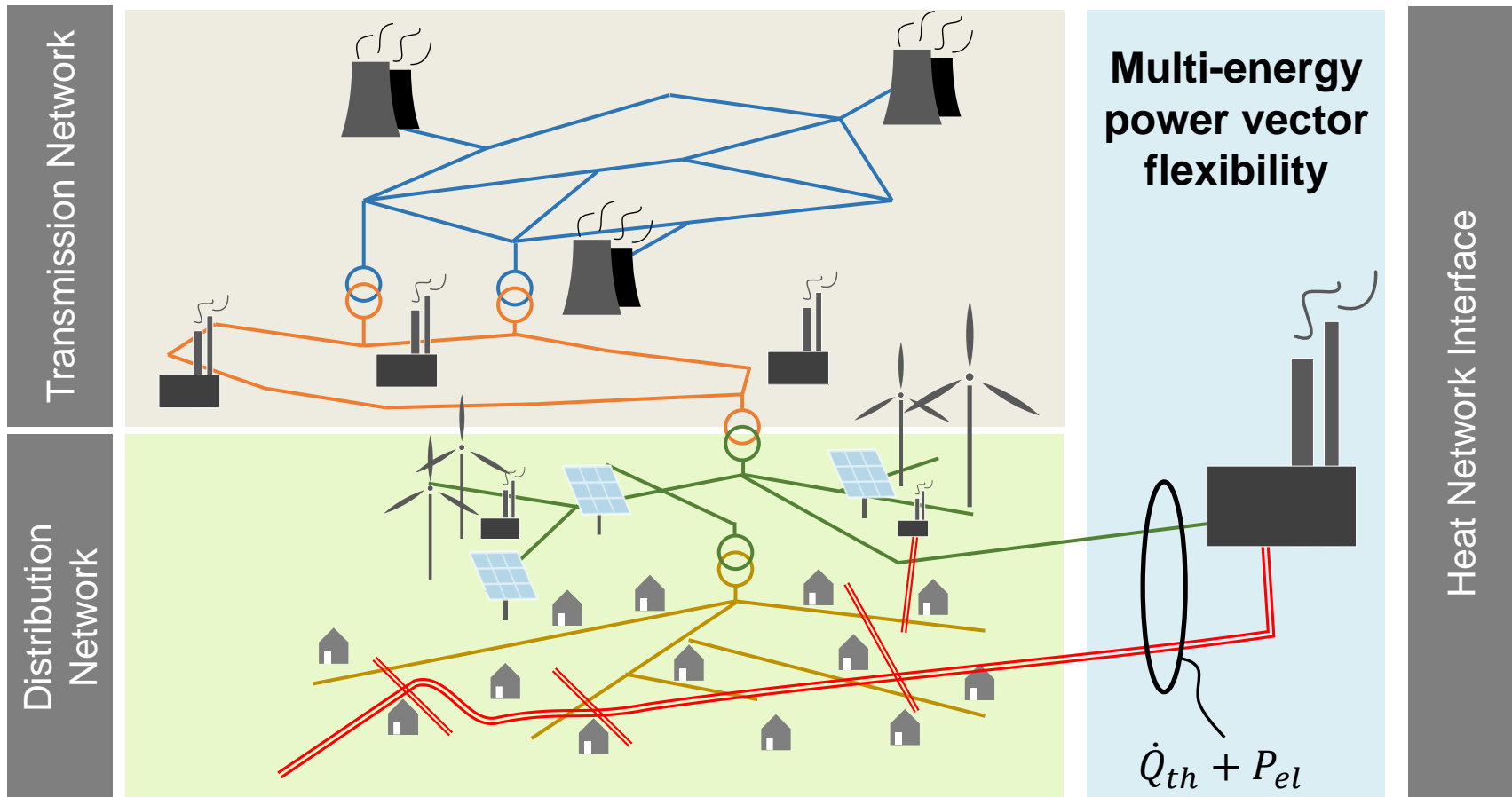




## **A technology agnostic system platform for real options based management of integrated energy systems**

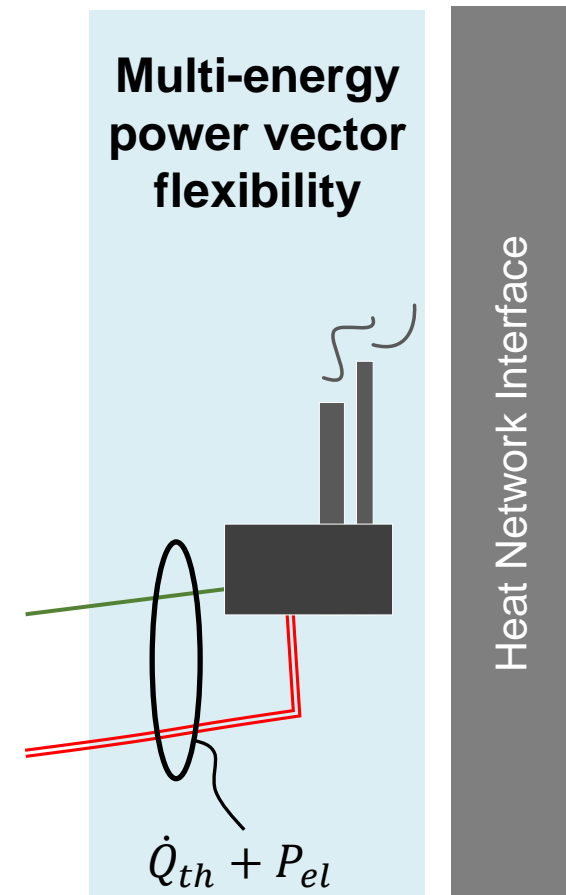
*Jonas Hinker, M.Sc.*

## Motivation: the system we are talkig about...



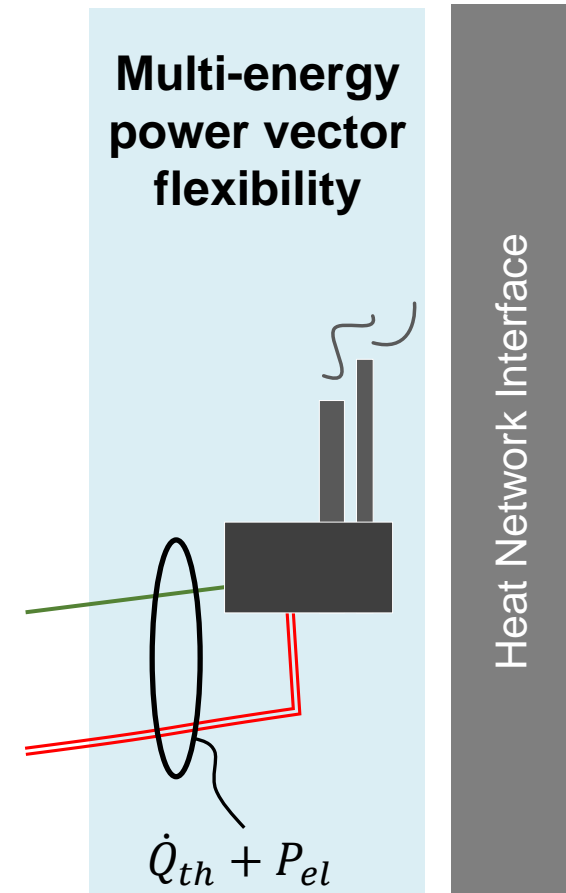
## Motivation: what is the (current/future) business case?

- Can the customer base for heat be maintained?
  - Is it favourable to produce electrical energy?
  - How competitive is district heating in comparison to wall-hung boilers?
  - Will regulation require decarbonization? (by certification/measurement?)
  - ...
- ➔ **Growing complexity** of investment problem
- ➔ **Growing uncertainty!**

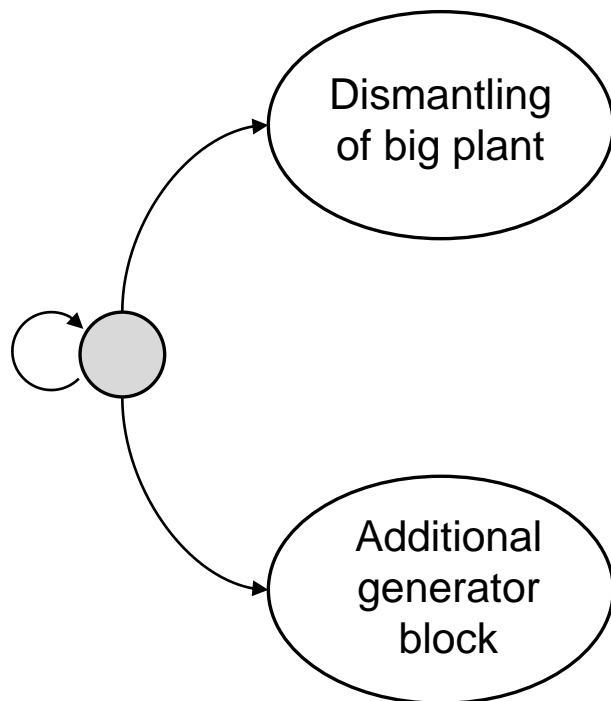


## Motivation: growing uncertainty about optimal supply systems

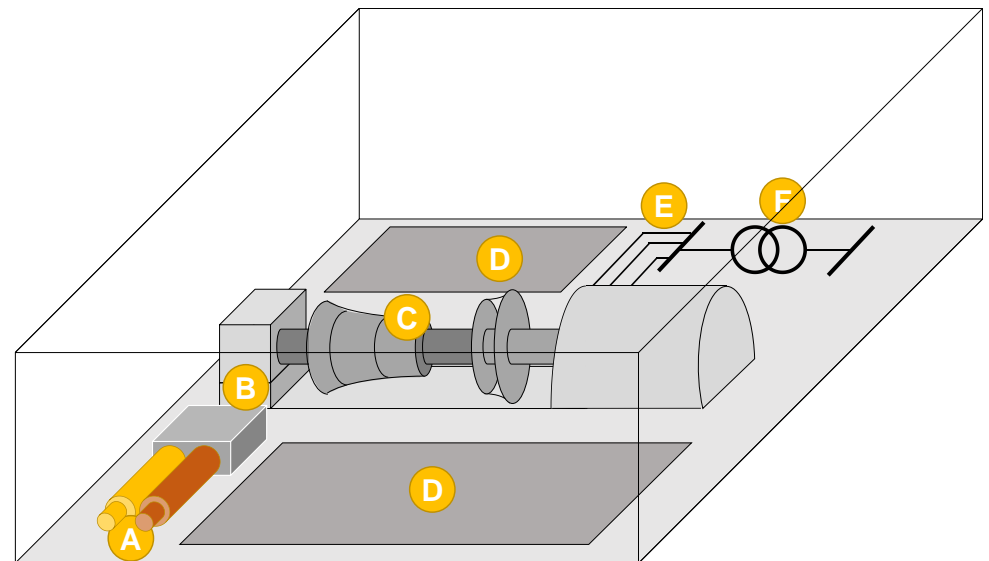
- **Which technology** should be used for feeding district heating systems?
  - Separate generation of electricity and heat?
  - Combined heat and power?
  - Even fuel cells?
  - Waste?
  - Heat pumps? (geothermal? or supply/return?)
  - Gas boilers?
  - Thermal storage?
  - Electric storage (batteries)?
- ➔ **Why that in all technologies?**
- ➔ **What size/dimension?**
- ➔ **For which use case?**



## Management of big generators

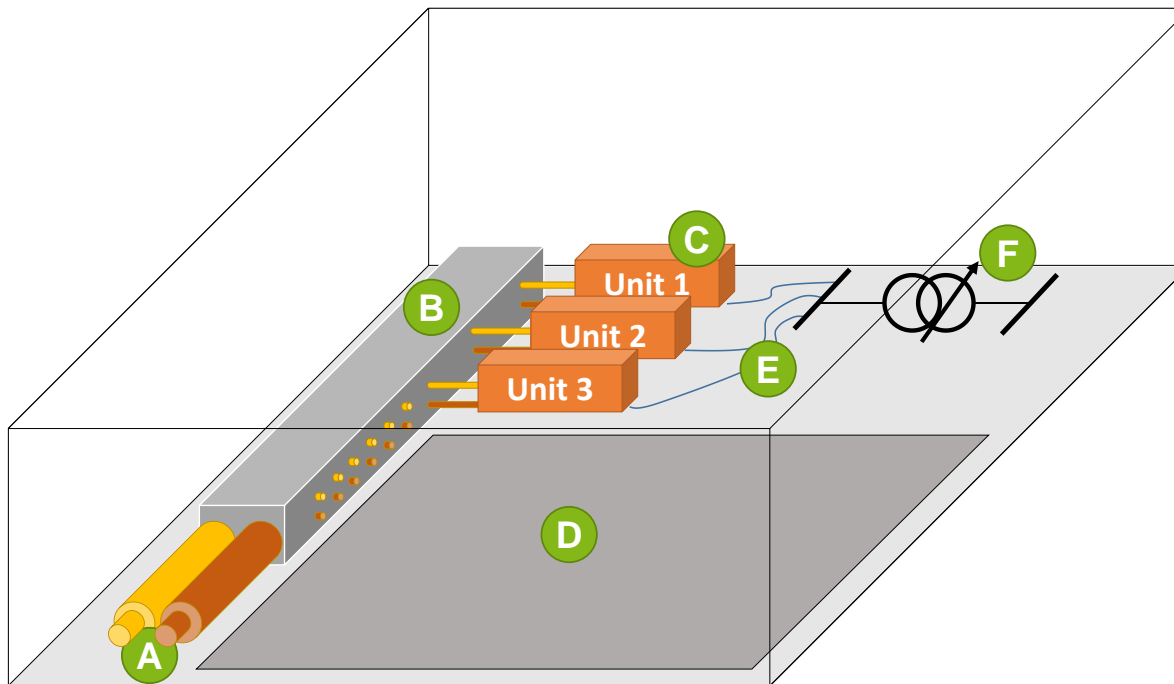


- Options limited
- One size
- Must fit for 50 years (depreciation)
- ➔ inflexible design



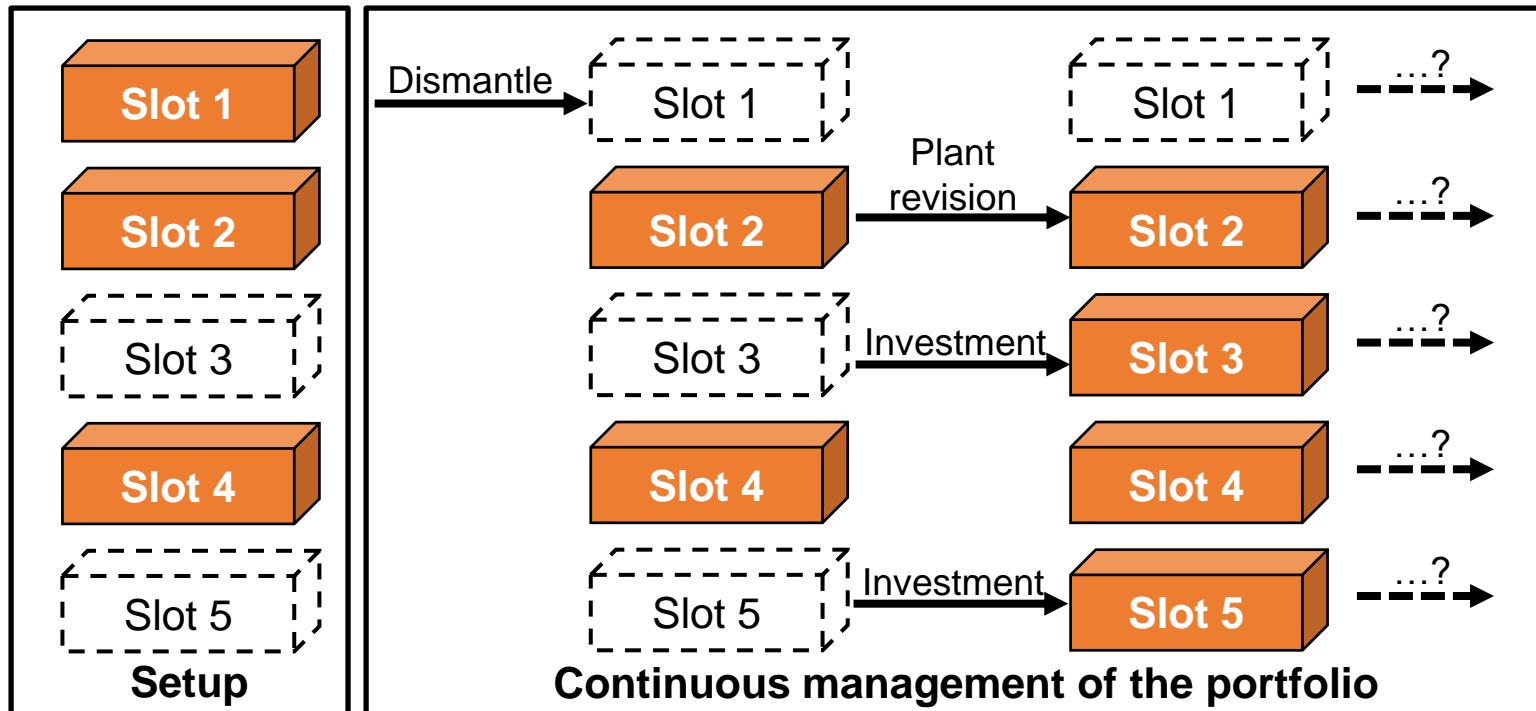
## The platform®

- Objective:
  - make heat and power generation manageable
  - decrease marginal investment
- Six simple elements:



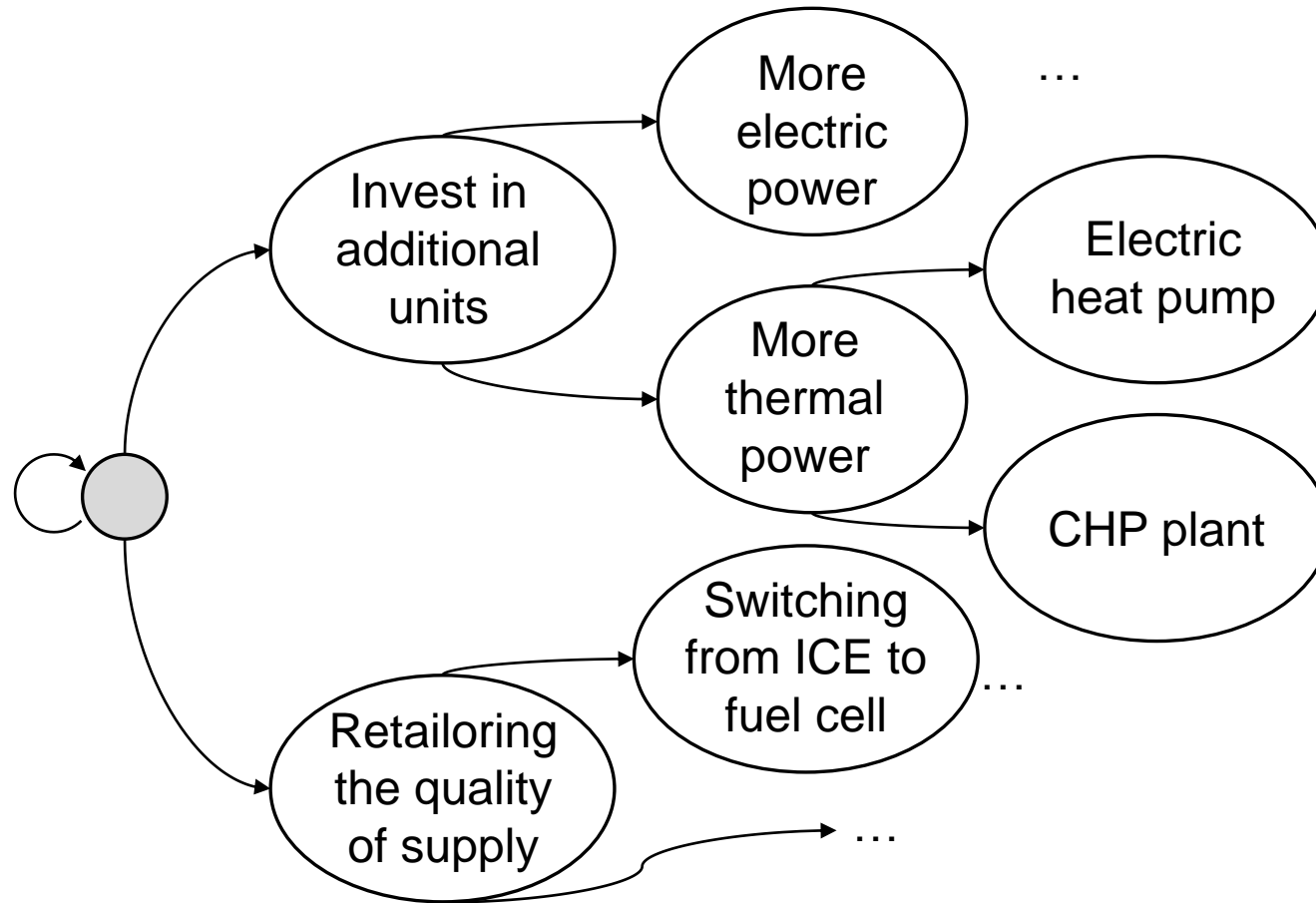
- A** Connection to district heating system
- B** Flexible hydraulic patch panel
- C** Installed units (20"/40" containers)
- D** Space for further extensions
- E** Electric connection to bus bar
- F** (OLTC) step-up transformer (high rating)

## Modularity allows management over decades!



- ➔ No regrets: start with a cheap investment, transform into 100% renewables
- ➔ Integrate prototypes, gather know-how for their operation (e.g., fuel cells)
- ➔ Easier revision management
- ➔ Revision can be trigger for change of portfolio, but also legislative actions

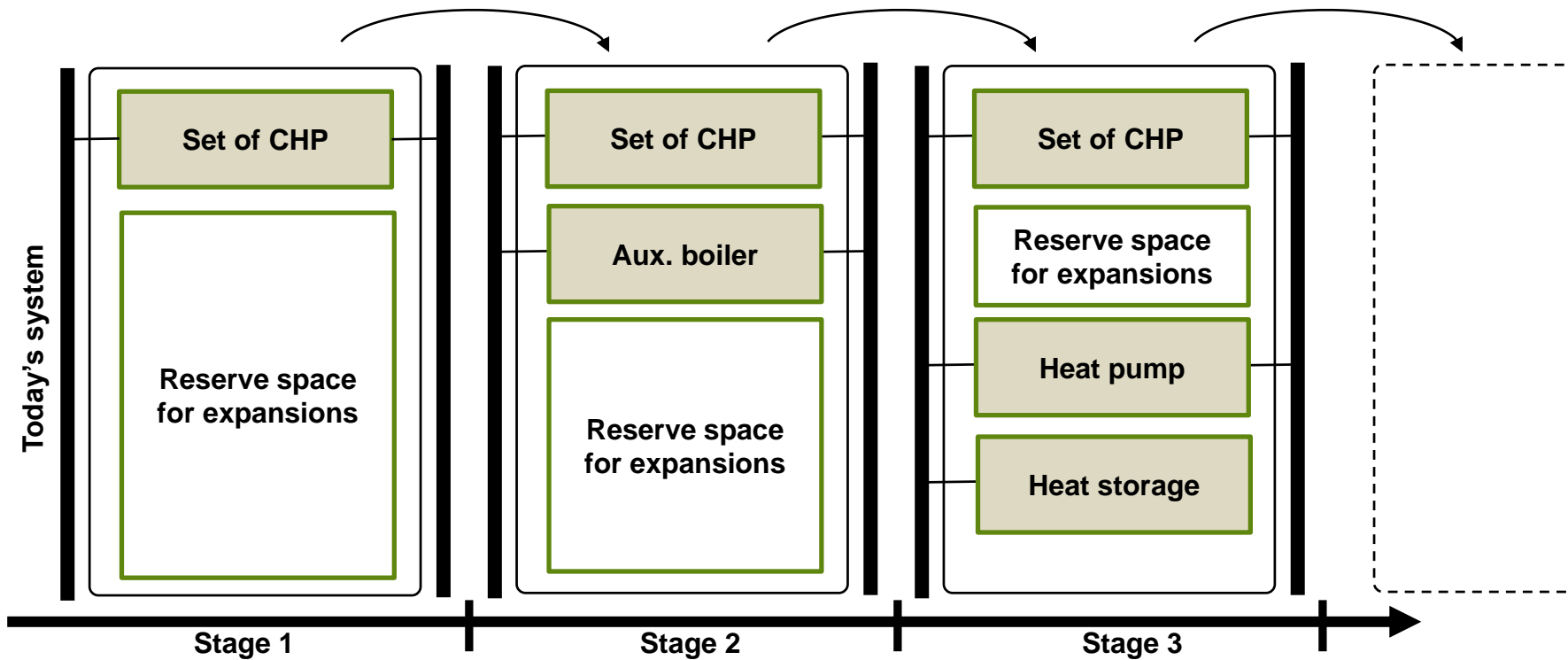
## So what are my real options? Are they valuable?



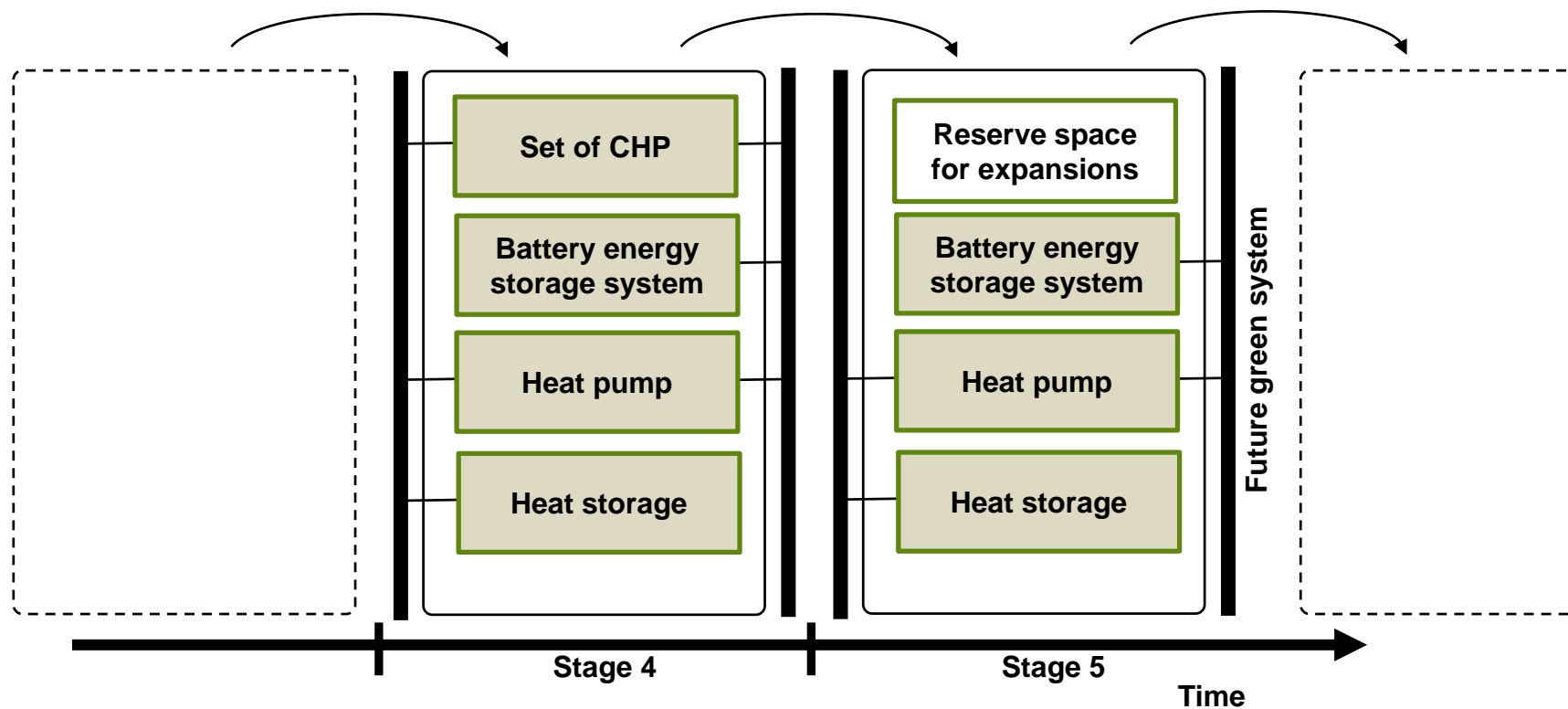
- Real options unlimited
  - Enables the decarbonization of heat
  - Relieves electrical grid (wind peaks)
  - Can generate
    - Heat + power
    - Power
    - Heat
    - Heat from power
    - ...
- ➔ **Valuable for sustainability**



## A sample story for the development of a portfolio (1/2)



## A sample story for the development of a portfolio (2/2)



## Conclusions and main take-aways

- **Future-proof heat and power solution** wanted
- High level of uncertainty for optimal plant design
  
- **Modularity** and **standardization** of individual units suggested
- **Multiple modules** replace conventional turbine (CHP) solution
  
- **Identical heat and power output** can be achieved (see other paper)
- **Real-options** are made available: management has control
  
- ➔ **Future-proof** by being completely **technology-agnostic**:  
all-electric, all-conventional, all-waste, all-geothermal, all-<...>
- ➔ Likely best case: **a mix** thereof
  
- **Spread the word!**

## Selected references

- ***J. Hinker et al.*: "Adaptable Energy Systems Integration by Modular, Standardized and Scalable System Architectures: Necessities and Prospects of Any Time Transition",** Energies, Volume 11(3), p.581, 2018, <https://doi.org/10.3390/en11030581>
- ***J. Hinker, H. Knappe, J. Myrzik*: "Precise Assessment of Technically Feasible Power Vector Interactions for Arbitrary Controllable Multi-Energy Systems",** IEEE Transactions on Smart Grid, t.b.a, **accepted**, early access, <https://doi.org/10.1109/TSG.2018.2858855>



Thank you for your attention!

Questions/remarks/criticism?

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Connect on ResearchGate!

